MINOR AND TRACE ELEMENT PARTITIONING BETWEEN IMMISCIBLE HIGH-FE BASALTS AND HIGH-SI RHYOLITES. AN EXAMPLE FROM MELT INCLUSIONS IN MARE BASALTS. Shearer, C.K., Wiedenbeck, M., Spilde, M.N., and Papike, J.J., Institute of Meteoritics, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, N.M.

INTRODUCTION. The role of liquid immiscibility during the generation of "granitic" magmas in basalt-dominated planetary systems (i.e., Moon, early terrestrial crust) has been debated since silicate immiscibility was first proposed as a magmatic process by Rosenbusch and Zirkel in the late 19th century. The "fractionation" of elements between immiscible basaltic-rhyolitic melts is thought to differ from the "fractionation" resulting from the crystallization of a basaltic magma that produces a residual rhyolitic melt. Such differences can be used to distinguish between granites produced by these different processes [1,2,3]. Several studies [i.e. 4,5,6] have calculated elemental partitioning between basalt and rhyolite using lunar lithologies with textural relationships only suggestive of an liquid immiscibility origin. Such observations have been used as evidence for indicating the importance of liquid immiscibility during late-stage crystallization of early planetary magma oceans and in the generation of "lunar granites" [3,4,5,6]. Small-scale liquid immiscibility has been reported in melt inclusions in a variety of lunar basalts [7]. Unlike previous studies [4,5,6], the textures exhibited by these melt inclusions unquestionably represent co-existing immiscible melts. Here, we report the element partitioning between high-Fe basaltic melts and high-Si, "rhyolitic" melts coexisting within inclusions in plagioclase crystals from mare basalts.

APPROACH. Melt inclusions of appropriate size were identified in mare basalts using optical microscopy. This initial study focused on melt inclusions associated with plagioclase. Using electron microprobe techniques individual inclusions were imaged and individual phases were analyzed. Trace element analyses of these documented immiscible "melts" were performed using a Cameca ims 4f ion microprobe at the University of New Mexico. The ion microprobe analyses were done under the following conditions: Analyses were performed using an O^- primary beam accelerated through a nominal potential of 10kV and focused into an 8 micron diameter area. Positive secondary ions (REE, Zr, Ba, Sr, U, Th) were counted and normalized to ^{30}Si and SiO_2%. A suite of basaltic and rhyolitic glass standards were used to establish ion yields for each element and each bulk composition.

DATA. These immiscible melt inclusions are typically rectangular in shape with orbicular rhyolite immersed in a basaltic matrix (FIGURE 1). Several inclusions were observed to have more than one orbicular rhyolite mass. Individual inclusions are up to 120 μm in length with the immiscible "rhyolite" spherules reaching 40 μm in diameter. The basalt component of the inclusion is quartz-hypersthene normative with low Mg# (0.38 to 0.04), and a relatively wide range in FeO (20% to 38%) and SiO_2 (35% to 50%). The "rhyolitic" component is corundum normative with a range of compositions from a high-Si, -K rhyolite to anomalously high-Si "rhyolite". The anomalous "rhyolites" are associated with basaltic inclusions with lower Al_2O_3, alkali element abundance and higher Mg#. Coexisting basalt-rhyolite pairs plot across fields of immiscibility as defined by Roedder [2] (FIGURE 2). Basalts are more enriched in REE than the coexisting rhyolite (FIGURE 3). The basalt has a negative Eu anomaly, whereas the rhyolite has either a slight positive Eu anomaly or no inflection at Eu. Overall REE patterns for the basalt and rhyolite are generally flat. In addition to the REE, Nb, Zr, Ti, P, Mn, S and U are enriched in the basalt component relative to the coexisting rhyolite (FIGURE 3). Ba and K are more enriched in the rhyolite, whereas the relative enrichment of Sr is dependent upon melt composition. Sr is enriched in the basalt when it coexists with the high-Si rhyolite, but is slightly depleted in the basalt when it coexists with the very high-Si rhyolite. The behavior of most of these elements in these melt inclusions are similar to that determined by experimental studies [1]. Like the experimental studies, the immiscible lunar basalts are enriched in the REE, Zr, and Ti relative to the coexisting rhyolites. This enrichment is more pronounced in the lunar examples of immiscibility. Unlike the experimental studies, Ba and occasionally

Sr prefer the rhyolitic component. These differences may be a function of melt composition.

CONCLUSIONS. Based on these observations, the following conclusions can be reached: (1) Evidence for small-scale liquid immiscibility processes are preserved in lunar basalts. (2) Liquid compositions generally agree with experimentally determined fields of liquid immiscibility. (3) Minor elements such as S, P, Ti, and Mn are partitioned into the high-Fe basalt component, whereas, K and Na are partitioned into the rhyolite component. (4) Zr, U, Nb, and REE are partitioned into the high-Fe basalt component, whereas, Ba is partitioned into the rhyolite component. The behavior of Sr is variable. (5) By comparing elemental partitioning in melt inclusions to compositional differences between evolved mare basalts and lunar granites (FIGURE 4), the lunar granites thus far considered in this study appear to be a product of fractional crystallization rather than large-scale liquid immiscibility.

REFERENCES. [1] Watson (1976) Contrib. Min. Pet. 56, 119-134. [2] Roedder (1979) In *The Evolution of the Igneous Rocks* (ed. H.S. Yoder) 15-58. [3] Ryerson and Hess (1980) GCA 44, 611-624. [4] Taylor et al. (1971) PLSC 2nd, 855-871. [5] Neal and Taylor (1989) GCA 53, 529-541.[6] Neal and Taylor (1991) LPSC XXII, 967-968. [7] Roedder (1984) Reviews in Mineralogy 12.

FIGURE 1. BEI and compositional maps (reverse images) of melt inclusion in plagioclase from a Apollo 12 olivine basalt.

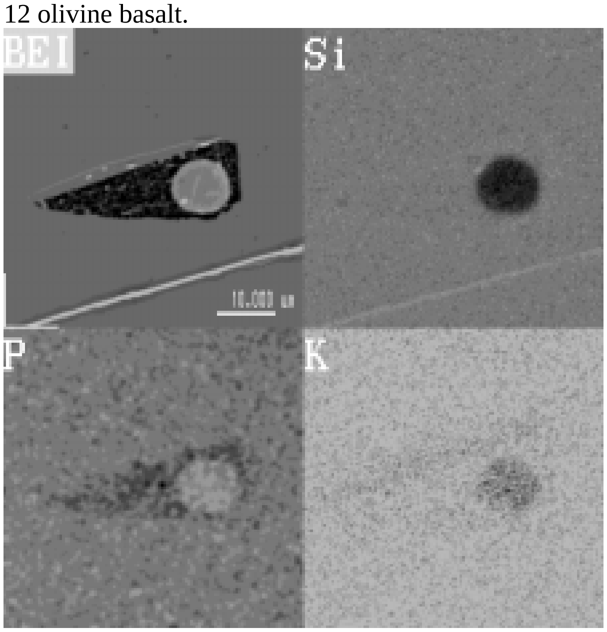

FIGURE 2. Plot of selected EMP analyses of immiscible melts (open circles) from mare basalts. Fields of liquid immiscibility are also shown.

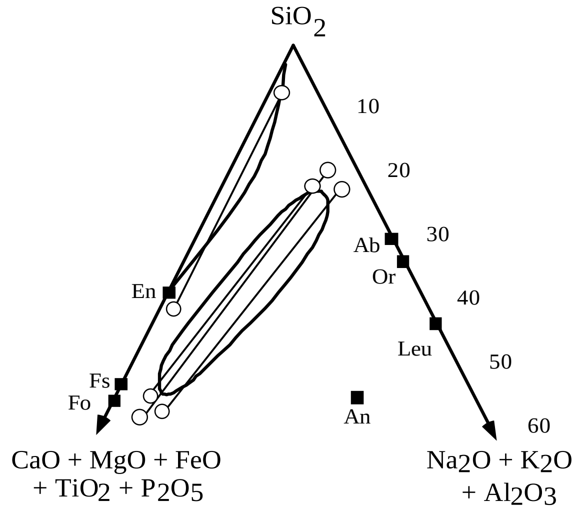

Figure 3. Comparison between immiscible basaltic and rhyolitic melts.

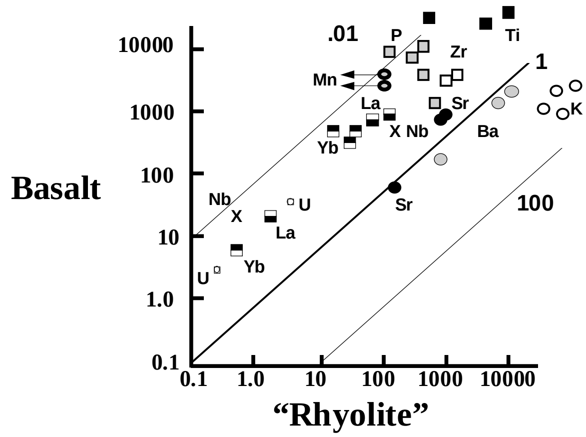

Figure 4. Comparison between lunar basalts and granites.